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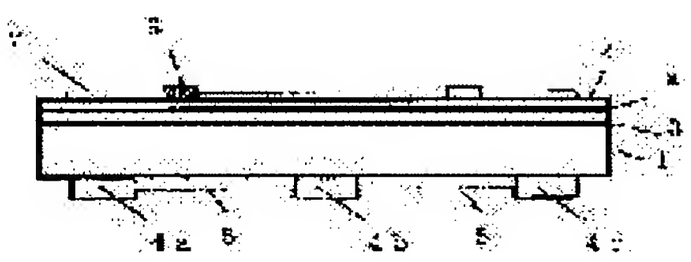
(54) SOLAR BATTERY CELL AND SOLAR BATTERY MODULE USING THE SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To suppress an output loss to a minimum even when cell cracking occurs on the overlapping portion of an aluminium electrode and a silver electrode formed on the rear surface of a semiconductor wafer.
SOLUTION: Different conductive regions are formed on one principal surface side and the other principal surface side of the semiconductor wafer, a front surface electrode composed of a band-shaped bus bar part for output takeout and a finger part for electricity collection is formed on one principal surface side, and the rear surface electrode composed of a band-shaped bus bar part for output takeout and an electricity collecting part, formed over all the surface except for the area, where this bus bar part for output takeout is formed, is formed on the other principal surface side. In such a solar battery cell, the band-shaped bus bar part for output takeout on the other principal surface side is formed almost on the center of the electricity collecting part on the other principal surface side and formed, on both the confronting terminal parts of such an electricity collecting part.

(a)



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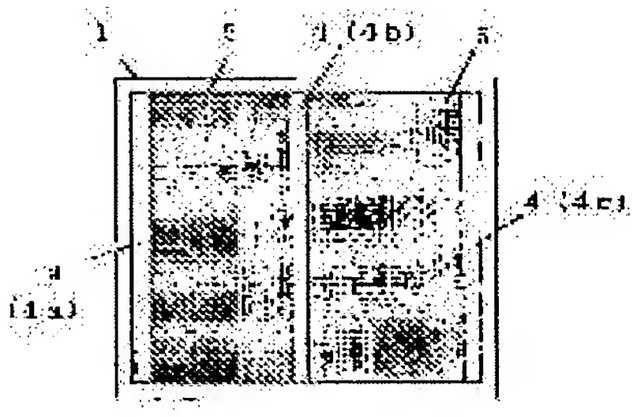

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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] Form an electric conduction field which is different in other 1 principal plane [of a semi-conductor substrate], and principal plane side, and the surface electrode which changes from the band-like bus bar section for output fetch and the finger section for current collection to this 1 principal-plane side is formed. In the solar battery element in which the rear-face electrode which changes from the band-like bus bar section for output fetch and the current collection section formed all over the abbreviation of those other than the field where this bus bar section for output fetch was formed to other principal plane side was formed The solar battery element characterized by forming in the both ends to which this current collection section counters while forming the bus bar section for the band-like output fetch by the side of a principal plane besides the above in the abbreviation center section of the current collection section by the side of other principal planes.
[Claim 2] The solar cell module which arranged the rear-face member and was united with other principal plane side while connecting the solar battery element comrade who prepares two or more said solar battery elements, and adjoins by the path cord and arranging the translucency member in the 1 principal-plane side.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the solar cell module using the solar battery element and it by which the bus bar section for output fetch was prepared in the table rear face of a semi-conductor substrate.
[0002]
[Description of the Prior Art] The general structure of a solar battery element is shown in drawing 4 . Drawing 4 (a) is a sectional view and drawing which looked at drawing 4 (b) from the background. As for the semi-conductor substrate which 11 shows one conductivity type (for example, P type), the field which the Lynn atom diffuses 11a into the surface part of the semi-conductor substrate 11 at high concentration, and presents other conductivity types, and 12, in drawing 4 (a) and (b), the antireflection film by the side of 1 principal plane and 13 are semiconductor junction. The part in which this antireflection film 12 is equivalent to an electrode is etched, or an electrode is formed from on that. It is also known that there is effectiveness as a rear-face electric-field layer which a silver electrode for 14 to take out an output from a rear face and 15 are rear-face aluminum electrodes, and prevents the carrier generated with the rear face when this was able to be burned on a silicon substrate 11 recombining. Although the electrode 14 which uses silver as a principal component, and the electrode 15 which uses aluminum as a principal component are formed with the rear face, in order that both may maintain electric conduction, it is necessary for mutual parts to overlap. 16 is the bus bar section for output fetch of the surface electrode with which the wiring member which connects the adjoining solar-battery comrade is soldered, and many finger electrodes 17 for current collection are formed at right angles to this bus bar section 16 for output fetch. Both arrange arrangement of surface electrodes 16 and 17 and the rear-face electrodes 14 and 15 in the location with which it laps on both sides of the semi-conductor substrate 11.
[0003] In order to solder the copper foil for output fetch etc. to the bus bar sections 14 and 16 for output fetch of such a solar battery element (un-illustrating), the solder coat is carried out beforehand. As for this solder coat, a dip method, a jet type, etc. are adopted. By the way, the current collection section 15 of the rear-face electrode which uses as a principal component the bus bar section 14 for output fetch and aluminum of the rear-face electrode which uses silver as a principal component In order that those from which a coefficient of thermal expansion called the silicon of a substrate ingredient, the silver of the charge for output fetch of a bus bar member, and the aluminum of the charge of current collection section lumber differs in the part which both overlap may gather After calcinating, concentration of stress took place, and there was a problem that a crack was occurred or divided into a solar battery element. When a crack etc. occurred in the part which the bus bar section 14 for output fetch which consists of silver, and the current collection section 15 which consists of aluminum overlap, the output of this part could not be taken out but had the problem of causing loss of an output.
[0004] This invention is made in view of the above-mentioned problem, and even if a crack occurs in the lap parts of the bus bar section for output fetch of a rear-face electrode, and the current collection section, it aims at suppressing loss of power to the minimum.
[0005]
[Means for Solving the Problem] In order to attain the above-mentioned object, in the solar battery element concerning this invention Form an electric conduction field which is different in other 1 principal plane [of a semi-conductor substrate], and principal plane side, and the surface electrode which changes from the band-like bus bar section for output fetch and the finger section for current collection to this 1 principal-plane side is formed. In the solar battery element in which the rear-face electrode which changes from the band-like bus bar section for output fetch and the current collection section formed all over the abbreviation of those other than the field where this bus bar section for output fetch was formed to other principal plane side was formed While forming the bus bar section for the band-like output fetch by the side of a principal plane besides the above in the abbreviation center section of the current collection section by the side of other principal planes, it formed in the both ends to which this current collection section counters.
[0006]
[Embodiment of the Invention] Hereafter, this invention is explained to a detail based on an accompanying drawing. Drawing 1 is drawing showing the structure of the solar battery element of this invention, and it is drawing where (a) looked at the sectional view and (b) looked at the solar battery element from the rear-face side. As for the semi-conductor substrate which 1 shows one conductivity type (for example, P type), the field which the Lynn atom diffuses 1a into the surface part of the semi-conductor substrate 1 at high concentration, and presents other

conductivity types, and 2, in drawing 1 (a) and (b), the antireflection film by the side of 1 principal plane and 3 are semiconductor junction. The part in which this antireflection film 2 is equivalent to an electrode is etched, or an electrode is formed from on that. It is also known that there is effectiveness as a rear-face electric-field layer which a silver electrode for 4 to take out an output from a rear face and 5 are rear-face aluminum electrodes, and prevents the carrier generated with the rear face when this was generally able to be burned on silicon 1 recombining. Although the electrode 4 which uses silver as a principal component, and the electrode 5 which uses aluminum as a principal component are formed with the rear face, in order that both may maintain electric conduction, it is necessary for mutual parts to overlap. the bus bar section of the surface electrode with which the wiring member which connects the solar-battery comrade whom 6 adjoins is soldered -- although not illustrated, the finger electrode 7 is installed at right angles to the bus bar section 6 along the front face of the antireflection film 2. Both arrange arrangement of surface electrodes 6 and 7 and the rear-face electrodes 4 and 5 in the location with which it laps on both sides of the semi-conductor substrate 1.

[0007] As shown in drawing 1 (b), one 4a and 4c are arranged to each ends to which 14b and a semi-conductor substrate counter the arrangement pattern of the rear-face silver electrode for output fetch in the center by the side of the rear face of the semi-conductor substrate 1. The arrangement pattern 5 of aluminum should lap with the ends of rear-face silver electrode 4b only in the inside of the rear-face silver electrodes 4a and 4c.

[0008] Consequently, although what a cel crack may generate is the inside of the silver electrodes 4a and 4c arranged to the central ends and cel ends of silver electrode 4b, if a crack does not occur in two or more places simultaneously, even if a crack occurs in which location, it becomes possible to take out an output, and is effective in suppressing loss of an output to minimum.

[0009] That is, as shown in drawing 2 , the part which the crack of a cel tends to generate is a part shown by ** of drawing - ** line.

[0010] Although lead wire (copper foil for output ejection) is a total of five of the table electrode 6 (2) and the rear-face electrode 4 (3), simultaneously, I hear that **, **, **, or ** breaks, or **, **, or ** breaks, and it has broken [two or more cracks of a cel]. ** When divided, an output can be taken out by central silver electrode 4b and silver electrode 4c of an another side edge. Moreover, although rear-face silver electrode 4b is divided into two, the cel by the side of rear-face silver electrode 4c, and the cel by the side of rear-face silver electrode 4a, when ** breaks, in one side, another side can take out an output only by rear-face silver electrode 4a by rear-face silver electrode 4b and rear-face silver electrode 4c.

[0011] ** When divided, it is the same as the time of ** breaking. ** When divided, it is the same as the time of ** breaking.

[0012] When there is no 4c and a crack occurs in ** when the number of electrodes on the back is two for example, it becomes impossible to take out the output applied to **-**. When the number of rear-face electrodes is two, however this may carry out arrangement of an electrode, it will surely happen.

[0013] In addition, although one continuous pattern showed each output fetch section of a rear-face electrode in drawing 1 , you may not necessarily be continuation but the dot pattern located in a line in the shape of a straight line is sufficient.

[0014] Next, based on drawing 3 , the manufacture approach of the solar battery element of this invention is explained.

[0015] First, the semi-conductor substrate 1 is prepared (refer to drawing 3 (a)). This semi-conductor substrate 1 consists of a single crystal or polycrystalline silicon. This semi-conductor substrate 1 contains 1 conductivity-type semi-conductor impurities, such as boron (B), 1x1016 - about three 1018 atoms/cm, and is an about [specific resistance 1.5ohmcm] substrate. In the case of single crystal silicon, it is formed of the Czochralski method etc., and, in the case of polycrystalline silicon, is formed of casting etc. Polycrystalline silicon can be mass-produced and is more advantageous than single crystal silicon in respect of a manufacturing cost. The ingot formed of the Czochralski method or casting is sliced in thickness of about 300 micrometers, and it cuts in 10cmx10cm or about [15cmx15cm] magnitude, and considers as a silicon substrate 1. Next, in order to defecate the cutting plane of this substrate 1, minute amount etching of the front face is carried out very much with fluoric acid, a FUTSU nitric acid, etc.

[0016] Next, by arranging the semi-conductor substrate 1 all over a diffusion furnace, and heating it in phosphorus oxychloride (POCl3) etc., field 1a which the surface part of the semi-conductor substrate 1 is made to diffuse the Lynn atom, and sheet resistance presents other conductivity types of 30-300ohms / ** is formed, and semiconductor junction 3 is formed (refer to drawing 3 (b)).

[0017] Next, pure water washes, after leaving only field 1a which presents other conductivity types by the side of the 1 principal plane of the semi-conductor substrate 1 and removing other parts (refer to drawing 3 (c)). Clearance of field 1a which presents other conductivity types other than a 1 principal-plane this semi-conductor substrate 1 side is performed by removing the resist film, after applying the resist film to the 1 principal-plane side of the semi-conductor substrate 1 and carrying out etching clearance using the mixed liquor of fluoric acid and a nitric acid.

[0018] Next, an antireflection film 2 is formed in the 1 principal-plane side of the semi-conductor substrate 1 (refer to drawing 3 (d)). This antireflection film 2 is formed by the plasma-CVD method which consists of a silicon nitride film etc., for example, is made to plasma-ize the mixed gas of a silane (SiH4) and ammonia (NH3) by glow discharge decomposition, and is made to deposit. In consideration of a refractive-index difference with the semi-conductor substrate 1 etc., this antireflection film 2 is formed so that a refractive index may become 1.8 to about 2.3, and it is formed in thickness with a thickness of about 500-1000A. In case this silicon nitride film is formed, it has the

passivation effectiveness, and it is effective in combining with the function of acid resisting and raising the electrical property of a solar battery.
[0019] Next, after applying the silver electrode material for forming the bus bar section 4 for output fetch and drying (refer to drawing 3 (e)), it applies and the rear-face aluminum electrode 5 is dried so that some above-mentioned rear-face silver electrode materials may not be covered (refer to drawing 3 (f)). In addition, this reverse is sufficient as the sequence which applies the silver ingredient and aluminum ingredient of this rear-face electrode. Next, the surface electrode ingredients 6 and 7 are applied, and it dries (refer to drawing 3 (g)).
[0020] Electrode materials 4 and 6 print with screen printing what this electrode material 5 added, respectively what added 10 - 30 weight section and 0.1 - 5 weight section to the aluminum 100 weight section, respectively, and made aluminum, the organic vehicle, and the glass frit the shape of a paste to the silver 100 weight section, and made 10 - 30 weight section and 0.1 - 5 weight section the shape of a paste for silver, the organic vehicle, and the glass frit. These electrode materials 4, 5, and 6 can be burned by calcinating about 1 to 30 minutes at 600-800 degrees C simultaneously after desiccation.
[0021] While preparing two or more above solar batteries, making sequential connection of the rear-face electrode of the solar battery contiguous to the surface electrode of a specific solar battery and arranging translucent part material, such as glass, in a front-face side, a sheet, aluminum foil, etc. of polyethylene are arranged, the whole is pasted up by translucency resin, such as ethylene vinyl acetate, and a solar cell module is formed in a rear-face side. Even if a crack occurs in the lap parts of the rear-face aluminum 5 of a rear-face electrode, and silver 4, a solar cell module is created using the solar battery which suppresses loss of power to the minimum.
[0022]
[Example] Next, the example of this invention is shown. 0.3mm in thickness and the P type silicon substrate of specific resistance 1.5 ohm-cm were prepared on 15cm square as a semi-conductor substrate. And the N type diffusion layer with a depth of 0.5 micrometers was formed by making phosphorus oxychloride (POCl3) into the source of diffusion with the thermal diffusion method.
[0023] Next, the antireflection film of silicon nitride was formed in the front face by the thickness of 800A by the plasma-CVD method, and the N type diffusion layer of the unnecessary section was removed.
[0024] After applying the silver for output ejection by the conventional pattern (2) and the pattern (3) concerning this invention as a rear-face electrode, printing the pattern of aluminum according to each pattern after that, screen-stenciling a silver paste also on a front face and being burned in 15 minutes 750 degrees, the solder coat of the above-mentioned collector front face was carried out, and the solar battery was manufactured. Loss of power when a cel crack occurs (one place) was compared. The result was shown in a table 1.
[0025]
[A table 1]

裏パターン	セル割れ	短絡電流 (mA)	開放電圧 (mV)	曲線因子	出力 (W)	出力損失率 (%)
本発明 (3本)	無	7580	602	0.756	3.45	—
	有	7510	601	0.722	3.26	94.5
従来 (2本)	無	7550	603	0.755	3.44	—
	有	5600	600	0.756	2.54	73.8

[0026] Although the loss of power at the time of a cel crack occurring was 73.8% by the pattern conventionally, according to this invention, it was able to be suppressed to 94.5%, as shown in a table 1.
[0027]
[Effect of the Invention] As mentioned above, while forming the bus bar section for the band-like output fetch by the side of the principal plane of everything but a semi-conductor substrate in the abbreviation center section of the current collection section by the side of other principal planes according to the solar battery element concerning claim 1 Although what a cel crack may generate is the inside of the silver electrode arranged to the central ends and cel ends of a silver electrode since it formed in the both ends to which this current collection section counters If two or more cracks do not occur simultaneously, even if a crack occurs in which location, it becomes possible to take out an output, and is effective in suppressing loss of an output to minimum.
[0028] Moreover, since a rear-face member is arranged and it unites with other principal plane side while according to the solar cell module concerning claim 2 connecting the solar battery element comrade who prepares two or more above-mentioned solar battery elements, and adjoins by the path cord and arranging a translucency member in a 1 principal-plane side, it becomes the solar cell module which reduced loss of power as much as possible.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the solar battery element concerning this invention.
[Drawing 2] It is drawing showing the relation of the cel crack of a solar battery element and loss of power concerning this invention.
[Drawing 3] It is drawing showing the manufacture approach of the solar battery element concerning this invention.
[Drawing 4] It is the sectional view showing the conventional solar battery element.
[Description of Notations]
1: The field which presents a semi-conductor substrate, and a conductivity type besides 1a:, 2:antireflection film, 3:semiconductor junction, the bus bar section for output fetch of 4:rear-face electrode, the current collection section of 5:rear-face electrode, the bus bar section for output fetch of 6:surface electrode, 7 : the finger section for current collection of a surface electrode

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[Translation done.]

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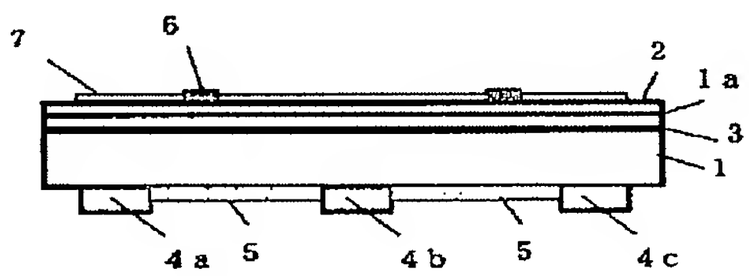
(54)【発明の名称】　太陽電池素子およびそれを用いた太陽電池モジュール

(57)【要約】
【課題】　半導体基板の裏面に形成するアルミニウム電極と銀電極との重なり部分で割れが発生しても出力損失を最小限に抑えることを目的とする。
【解決手段】　半導体基板の一主面側と他の主面側に異なる導電領域を形成し、この一主面側に帯状の出力取出用バスバー部と集電用フィンガー部とから成る表面電極を形成し、他の主面側に帯状の出力取出用バスバー部とこの出力取出用バスバー部が形成された領域以外の略全面に形成された集電部とから成る裏面電極を形成した太陽電池素子において、前記他の主面側の帯状の出力取出用のバスバー部をこの他の主面側の集電部の略中央部に形成すると共に、この集電部の対向する両端部に形成した。

(a)



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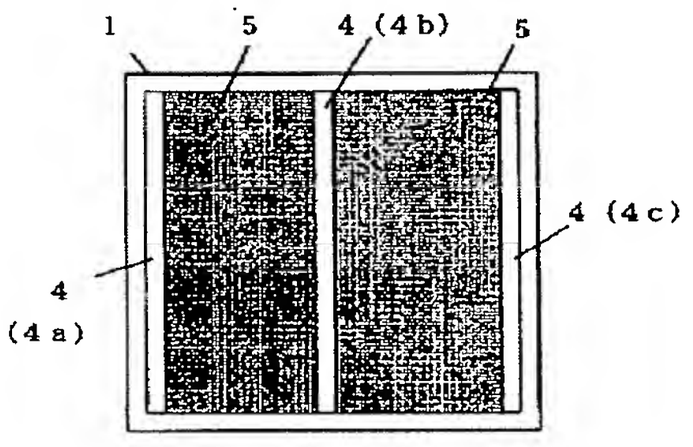


【特許請求の範囲】

【請求項１】　半導体基板の一主面側と他の主面側に異なる導電領域を形成し、この一主面側に帯状の出力取出用バスバー部と集電用フィンガー部とから成る表面電極を形成し、他の主面側に帯状の出力取出用バスバー部とこの出力取出用バスバー部が形成された領域以外の略全面に形成された集電部とから成る裏面電極を形成した太陽電池素子において、前記他の主面側の帯状の出力取出用のバスバー部をこの他の主面側の集電部の略中央部に形成すると共に、この集電部の対向する両端部に形成したことを特徴とする太陽電池素子。

【請求項２】　前記太陽電池素子を複数用意して隣接する太陽電池素子同志を接続線で接続して一主面側に透光性部材を配設すると共に、他の主面側に裏面部材を配設して一体化した太陽電池モジュール。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は半導体基板の表裏面に出力取出用バスバー部が設けられた太陽電池素子とそれを用いた太陽電池モジュールに関する。

【０００２】

【従来の技術と発明が解決しようとする課題】太陽電池素子の一般的な構造を図４に示す。図４（ａ）は断面図、図４（ｂ）は裏側から見た図である。図４（ａ）（ｂ）において、１１は一導電型（例えばＰ型）を示す半導体基板、１１ａは半導体基板１１の表面部分にリン原子が高濃度に拡散され他の導電型を呈する領域、１２は一主面側の反射防止膜、１３は半導体接合部である。この反射防止膜１２は電極に相当する部分がエッチングされもしくはその上から電極が形成される。１４は裏面から出力を取り出すための銀電極、１５は裏面アルミニウム電極であり、これがシリコン基板１１に焼き付けられた際には裏面で発生したキャリアが再結合することを防ぐ裏面電界層としての効果があることも知られている。裏面では銀を主成分とする電極１４とアルミニウムを主成分とする電極１５が形成されるが、両者は電気的伝導を保つために、互いの一部分が重なり合うことが必要になる。１６は隣接する太陽電池同志を接続する配線部材がハンダ付けされる表面電極の出力取出用バスバー部であり、この出力取出用バスバー部１６と垂直に集電用フィンガー電極１７が多数設けられている。表面電極１６、１７及び裏面電極１４、１５の配置は、両者が半導体基板１１を挟んで重なる位置に配置するようにする。

【０００３】このような太陽電池素子の出力取出用バスバー部１４、１６には出力取出用銅箔等（不図示）を半田付けするためにあらかじめ半田被覆されている。この半田被覆は、ディップ法、噴流式等が採用される。ところで銀を主成分とする裏面電極の出力取出用バスバー部１４とアルミニウムを主成分とする裏面電極の集電部１５は、両者が重なり合う部分では基板材料のシリコン、出力取出用バスバー部材料の銀、集電部用材料のアルミニウムという熱膨張率の異なるものが集まるために、焼成した後に応力の集中が起こり、太陽電池素子にクラックが発生したり、割れたりするという問題があった。銀から成る出力取出用バスバー部１４とアルミニウムから成る集電部１５とが重なり合う部分で割れなどが発生した場合には、この部分の出力は取り出すことができず、出力の損失を引き起こすという問題があった。

【０００４】本発明は上記問題に鑑みてなされたものであり、裏面電極の出力取出用バスバー部と集電部の重なり部分で割れが発生しても出力損失を最小限に抑えることを目的とする。

【０００５】

【課題を解決するための手段】上記目的を達成するために、本発明に係る太陽電池素子では、半導体基板の一主面側と他の主面側に異なる導電領域を形成し、この一主面側に帯状の出力取出用バスバー部と集電用フィンガー部とから成る表面電極を形成し、他の主面側に帯状の出力取出用バスバー部とこの出力取出用バスバー部が形成された領域以外の略全面に形成された集電部とから成る裏面電極を形成した太陽電池素子において、前記他の主面側の帯状の出力取出用のバスバー部をこの他の主面側の集電部の略中央部に形成すると共に、この集電部の対向する両端部に形成した。

【０００６】

【発明の実施の形態】以下、本発明を添付図面に基づき詳細に説明する。図１は本発明の太陽電池素子の構造を示す図であり、（ａ）は断面図、（ｂ）は太陽電池素子を裏面側から見た図である。図１（ａ）（ｂ）において、１は一導電型（例えばＰ型）を示す半導体基板、１ａは半導体基板１の表面部分にリン原子が高濃度に拡散され他の導電型を呈する領域、２は一主面側の反射防止膜、３は半導体接合部である。この反射防止膜２は電極に相当する部分がエッチングされもしくはその上から電極が形成される。４は裏面から出力を取り出すための銀電極、５は裏面アルミニウム電極であり、一般にこれがシリコン１に焼き付けられた際には裏面で発生したキャリアが再結合することを防ぐ裏面電界層としての効果があることも知られている。裏面では銀を主成分とする電極４とアルミニウムを主成分とする電極５が形成されるが、両者は電気的伝導を保つために、互いの一部分が重なり合うことが必要になる。６は隣接する太陽電池同志を接続する配線部材がハンダ付けされる表面電極のバスバー部、図示されていないが反射防止膜２の表面に沿ってバスバー部６と垂直にフィンガー電極７が設置されている。表面電極６、７及び裏面電極４、５の配置は、両者が半導体基板１を挟んで重なる位置に配置するようにする。

【０００７】図１（ｂ）に示すように、出力取出用の裏

面銀電極の配置パターンを半導体基板１の裏面側の中央に一本４ｂと半導体基板の対向する両端に一本ずつ４ａ、４ｃを配置する。アルミニウムの配置パターン５は裏面銀電極４ｂの両端と裏面銀電極４ａ、４ｃの内側だけで重なればよい。

【０００８】この結果、セル割れが発生する可能性があるのは中央の銀電極４ｂの両端とセル両端に配置した銀電極４ａ、４ｃの内側であるが、同時に２箇所以上で割れが発生しなければ、何れの位置で割れが発生しても出力を取り出すことが可能となり、出力の損失を最低限に抑える効果がある。

【０００９】つまり、図２に示すように、セルの割れが発生しやすい個所は図の①～④線で示した箇所である。

【００１０】リード線(出力取り出し用の銅箔)は表電極６(2本)と裏面電極４(3本)の合計5本であるが、セルの割れが同時に２箇所以上割れるというのは、①と②、③、④のいずれかが割れるとか、②と③、④のいずれかが割れるということである。①が割れたとき出力は中央の銀電極４ｂと他方端部の銀電極４ｃにより取り出すことができる。また、②が割れたときには裏面銀電極４ｂは裏面銀電極４ｃ側のセルと裏面銀電極４a側のセルの２つに分かれているが、一方は裏面銀電極４aのみでもう一方は裏面銀電極４ｂと裏面銀電極４ｃで出力を取り出すことができる。

【００１１】③がわれたときは②が割れたときと同じである。④が割れたときには①が割れたときと同じである。

【００１２】裏面の電極が２本の場合、例えば４ｃがないときは、③で割れが発生すると、③－④にかけての出力を取り出すことができなくなる。これは裏面電極が２本の場合には、電極の配置をどのようにしても必ず起こる。

【００１３】なお、図１では裏面電極の各々の出力取出部を連続した一本のパターンで示したが、必ずしも連続でなくてもよく、直線状に並んだドットパターンなどでもよい。

【００１４】次に、図３に基づいて、本発明の太陽電池素子の製造方法を説明する。

【００１５】まず、半導体基板１を用意する（図３（ａ）参照）。この半導体基板１は、単結晶又は多結晶シリコンなどから成る。この半導体基板１は、ボロン（Ｂ）などの一導電型半導体不純物を1×10^{16}～10^{18}ａｔｏｍｓ／ｃｍ^{3}程度含有し、比抵抗１．５Ωｃｍ程度の基板である。単結晶シリコンの場合は引き上げ法などによって形成され、多結晶シリコンの場合は鋳造法などによって形成される。多結晶シリコンは、大量生産が可能で製造コスト面で単結晶シリコンよりも有利である。引き上げ法や鋳造法によって形成されたインゴットを３００μｍ程度の厚みにスライスして、１０ｃｍ×１０ｃｍまたは１５ｃｍ×１５ｃｍ程度の大きさに切断してシリコン基板１とする。次に、この基板１の切断面を清浄化するために表面をフッ酸やフッ硝酸などでごく微量エッチングする。

【００１６】次に、半導体基板１を拡散炉中に配置して、オキシ塩化リン（ＰＯＣｌ$_3$）などの中で加熱することによって、半導体基板１の表面部分にリン原子を拡散させてシート抵抗が３０～３００Ω／□の他の導電型を呈する領域１ａを形成し、半導体接合部３を形成する（図３（ｂ）参照）。

【００１７】次に、半導体基板１の一主面側の他の導電型を呈する領域１ａのみを残して他の部分を除去した後に、純水で洗浄する（図３（ｃ）参照）。この半導体基板１の一主面側以外の他の導電型を呈する領域１ａの除去は、半導体基板１の一主面側にレジスト膜を塗布し、フッ酸と硝酸の混合液を用いてエッチング除去した後、レジスト膜を除去することにより行なう。

【００１８】次に、半導体基板１の一主面側に反射防止膜２を形成する（図３（ｄ）参照）。この反射防止膜２は例えば窒化シリコン膜などから成り、例えばシラン（ＳｉＨ$_4$）とアンモニア（ＮＨ$_3$）との混合ガスをグロー放電分解でプラズマ化させて堆積させるプラズマＣＶＤ法などで形成される。この反射防止膜２は、半導体基板１との屈折率差などを考慮して、屈折率が１．８～２．３程度になるように形成され、厚み５００～１０００Å程度の厚みに形成される。この窒化シリコン膜は形成する際にバッシベーション効果があり、反射防止の機能と併せて太陽電池の電気特性を向上させる効果がある。

【００１９】次に、出力取出用バスバー部４を形成するための銀電極材料を塗布して乾燥した後（図３（ｅ）参照）、裏面アルミニウム電極５を上記裏面銀電極材料の一部を覆わないように塗布して乾燥させる（図３（ｆ）参照）。なお、この裏面電極の銀材料とアルミニウム材料を塗布する順番はこの逆でもよい。次に、表面電極材料６および７を塗布して乾燥する（図３（ｇ）参照）。

【００２０】この電極材料５はアルミニウムと有機ビヒクルとガラスフリットをアルミニウム１００重量部に対してそれぞれ１０～３０重量部、０．１～５重量部を添加してペースト状にしたものを、電極材料４、６は、銀と有機ビヒクルとガラスフリットを銀１００重量部に対してそれぞれ１０～３０重量部、０．１～５重量部を添加してペースト状にしたものをスクリーン印刷法で印刷する。これら電極材料４、５、６は乾燥後に同時に６００～８００℃で１～３０分程度焼成することにより焼き付けられる。

【００２１】上述のような太陽電池を複数用意し、特定の太陽電池の表面電極と隣接する太陽電池の裏面電極を順次接続して、表面側にガラスなどの透光部材を配設するとともに、裏面側にポリエチレンのシートやアルミ箔などを配設して全体をエチレンビニルアセテートなどの

透光性樹脂で接着して太陽電池モジュールを形成する。裏面電極の裏面アルミニウム５と銀４の重なり部分で割れが発生しても出力損失を最小限に抑える太陽電池を用いて、太陽電池モジュールを作成する。

【００２２】

【実施例】次に本発明の実施例を示す。半導体基板として１５ｃｍ角で厚さ０．３ｍｍ、比抵抗１．５Ω・ｃｍのＰ型シリコン基板を準備した。そして熱拡散法でオキシ塩化リン（ＰＯＣｌ，）を拡散源として、深さ０．５μｍのＮ型拡散層を形成した。

【００２３】次に表面にプラズマＣＶＤ法で窒化シリコンの反射防止膜を８００Åの厚さで形成し、不要部のＮ＊型拡散層を除去した。

【００２４】裏面電極として出力取り出し用の銀を従来のパターン（２本）と本発明に係るパターン（３本）で塗布し、その後それぞれのパターンに応じたアルミニウムのパターンを印刷して表面にも銀ペーストをスクリーン印刷して７５０度１５分で焼き付けた後、上記集電極表面を半田被覆して太陽電池を製造した。セル割れが発生した場合（１個所）の出力損失の比較を行った。その結果を表１に示した。

【００２５】

【表１】

裏パターン	セル割れ	短絡電流 (mA)	開放電圧 (mV)	曲線因子	出力 (W)	出力損失率 (%)
本発明 (3本)	無	７５８０	６０２	０．７５６	３．４５	—
	有	７５１０	６０１	０．７２２	３．２６	９４．５
従来 (2本)	無	７５５０	６０３	０．７５５	３．４４	—
	有	５６００	６００	０．７５６	２．５４	７３．８

【００２６】表１に示した通り、セル割れが発生した際の出力損失は、従来パターンでは７３．８％であったが、本発明によれば９４．５％に抑えることができた。

【００２７】

【発明の効果】以上のように、請求項１に係る太陽電池素子によれば、半導体基板の他の主面側の帯状の出力取出用のバスバー部をこの他の主面側の集電部の略中央部に形成すると共に、この集電部の対向する両端部に形成したことから、セル割れが発生する可能性があるのは中央の銀電極の両端とセル両端に配置した銀電極の内側であるが、同時に２箇所以上での割れが発生しなければ、何れの位置で割れが発生しても出力を取り出すことが可能となり、出力の損失を最低限に抑える効果がある。

【００２８】また、請求項２に係る太陽電池モジュールによれば、上記太陽電池素子を複数用意して隣接する太陽電池素子同志を接続線で接続して一主面側に透光性部※材を配設すると共に、他の主面側に裏面部材を配設して一体化することから、出力損失を極力低減した太陽電池モジュールとなる。

【図面の簡単な説明】

【図１】本発明に係る太陽電池素子を示す図である。

【図２】本発明に係る太陽電池素子のセル割れと出力損失との関係を示す図である。

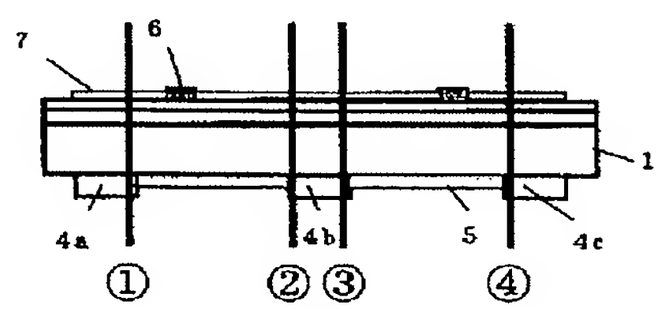
【図３】本発明に係る太陽電池素子の製造方法を示す図である。

【図４】従来の太陽電池素子を示す断面図である。

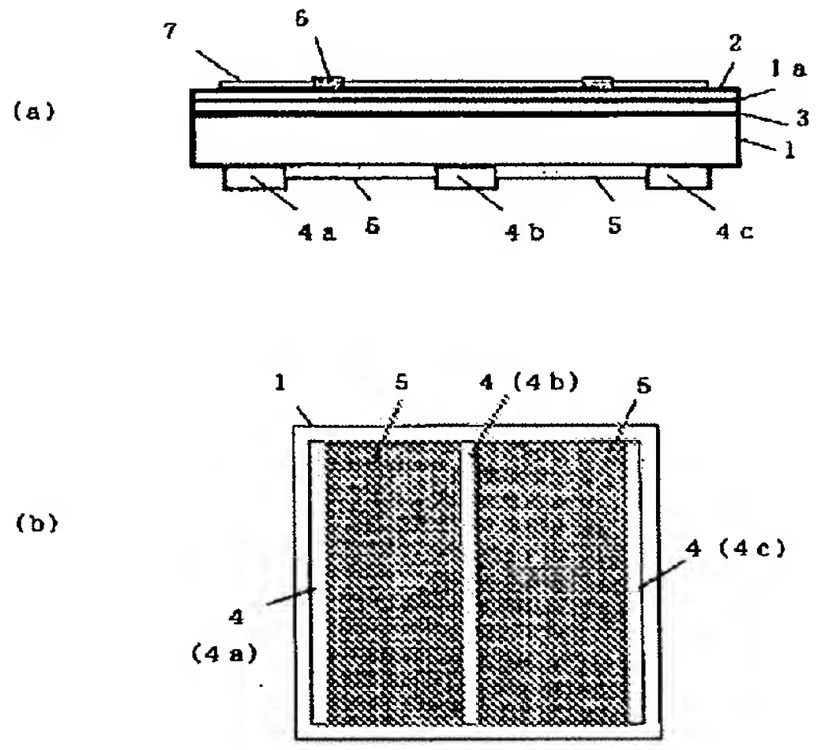
【符号の説明】

１：半導体基板、１ａ：他の導電型を呈する領域、２：反射防止膜、３：半導体接合部、４：裏面電極の出力取出用バスバー部、５：裏面電極の集電部、６：表面電極の出力取出用バスバー部、７：表面電極の集電用フィンガー部

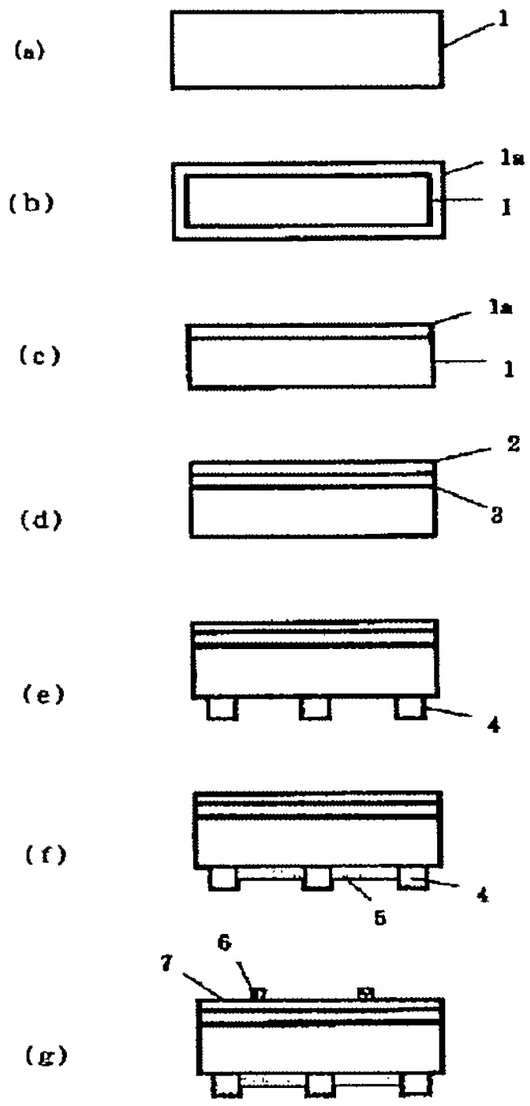
【図２】



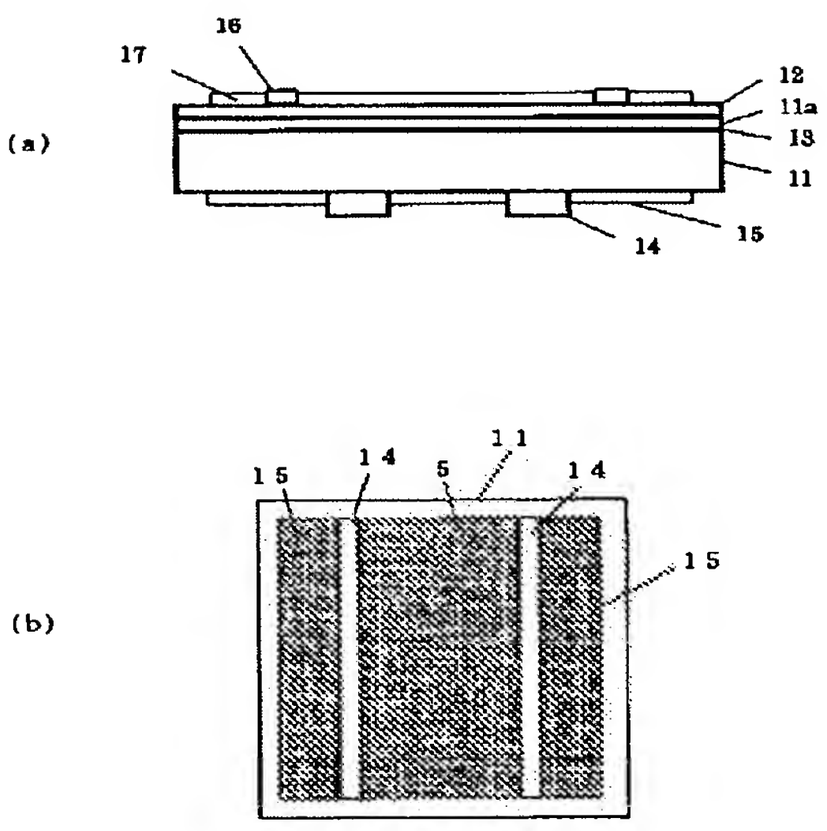
【図１】


(a)
7
6
2
1a
3
1
4a
5
4b
5
4c
(b)
1
5
4 (4b)
5
4 (4c)
4
(4a)

【図３】


(a)
1
(b)
1a
1
(c)
1a
1
(d)
2
3
(e)
4
(f)
4
5
(g)
6
7

【図４】


(a)
16
17
12
11a
13
11
15
14
(b)
11
14
15
5
14
15